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convincing the uninformed that malaria-control through the control of mosquitoes is not only possible, but that it pays. While the inaccuracies do not materially detract from the practical value of the book, it is to be hoped that in the interest of truth they will be corrected in a future edition.

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SPECIAL ARTICLES

THE ORIENTAL CYCADS IN THE FIELD

CYCADS in the field, cycads in the botanical garden and cycads in the greenhouse, are so different that descriptions based upon plants growing in the garden should be checked by observations in the field, and accounts based upon greenhouse material must be viewed with great suspicion.

In the field, *Cycas circinalis* is said to produce a crown of leaves every year, and under ordinary greenhouse conditions, new crowns are usually produced every year; but where the heat is extreme and the rainfall excessive, two crowns each year may be produced for many years in succession. *Dioon* at Kew surpasses anything I have ever seen at Chavarrillo, but if the Kew specimens should be exposed to the blazing sun of the Mexican tropics, their magnificent crowns would probably wither in a few days. In cycad seedlings at the University of Chicago, scale leaves, which in the field would never have been anything but scale leaves, quite regularly develop into foliage leaves. The cycads, like roses, pinks and chrysanthemums, may appear to better advantage on account of greenhouse conditions, but for phylogenetic studies, their value is doubtful.

During the past year it was my privilege to study in the field the five oriental genera of cycads. Two of these genera are found only in South Africa, two only in Australia, and the remaining genus, *Cycas*, extends from Japan to Australia and Madagascar. Thus all the oriental cycads, except *Cycas*, are confined to the southern hemisphere; while all the western cycads, except *Zamia*, are confined

to the northern. No genus is common to the east and the west.

The three genera found in Australia are *Cycas*, *Bowenia* and *Macrozamia*. All three are abundant in Queensland, the northeast part of Australia, and *Cycas* and *Bowenia* may be confined to this region; *Macrozamia* extends into New South Wales and is represented by at least one species on the western coast.

Cycas, in Australia, is represented by five species, only one of which, *Cycas media*, was studied in the field. The other three were seen in gardens. *Cycas media* was studied at Rockhampton, on the Tropic of Capricorn, and at Freshwater, in the Cairns district, about 700 miles farther north.

Eichler's account, in Engler and Prantl's "Die Natürlichen Pflanzenfamilien," gives *Cycas media* a height of 20 meters, making it the tallest of the cycads. This is undoubtedly a mistake. Dr. F. M. Bailey, in his "Flora of Queensland," states that the species reaches a height of 8 to 10 feet (2.4 to 3.05 meters) and sometimes twice that height. Mr. Simmons, director of the Botanical Garden at Rockhampton, and Mr. Anderson, director of the Botanical Garden at Townsville, assured me that the plant seldom exceeds 3 meters in height and that specimens 6 meters in height were extremely rare. Mr. Sydney Snell, who for many years has lived and hunted in the Berserker Ranges near Rockhampton, showed me the tallest specimen he had seen, and it measured about 6 meters. I received similar reports all the way from the southern to the northern limit of the species. At Freshwater, in the Cairns district, I found one plant which was 7.01 meters in height. The mistake in Eichler's account probably arose in mistaking feet for meters.

A section of the trunk shows the polyxylic condition, but a specimen 2 meters high shows only two or three zones of wood, while a specimen of *Cycas revoluta* half a meter in height might show as many as three or four.

The trunk is ribbed, like that of *Dioon spinulosum*, and the ribs are due to the alternation of foliage leaves and scale leaves or

sporophylls. The ovules have a bright orange color.

The taxonomic descriptions of the four Australian species of *Cycas* are very incomplete, but may be sufficient for identification. All the species grow in the omnipresent but scanty eucalyptus bush, often associated with *Xanthorrhiza*, *Pandanus* and *Macrozamia*.

Material has been secured for a complete morphological study, including the anatomy of the adult plant and the seedling.

The most peculiar of the Australian cycads is *Bowenia*, whose bipinnate leaves readily distinguish it from all other cycads. There are two species, *Bowenia spectabilis*, which is abundant in the northern part of Queensland, about Cooktown, Cairns and Innesfail; and *B. serrulata*, which is at its best in the neighborhood of Rockhampton, about 700 miles south of Cairns. The range of the species could not be determined, but from the reports of directors of botanical gardens, amateur botanists and others, there seems to be a considerable region between the Rockhampton and Cairns districts, where neither species has been found. *Bowenia spectabilis* has only a few leaves, but they have a deep green color and retain their beauty long after they have been cut from the plant. *Bowenia serrulata* has a much greater display of foliage and, in some places, is so abundant that it forms a dense, but easily penetrated underbrush.

The stems of both species are subterranean, so that one of the most striking differences between them might be overlooked. The stem of *B. spectabilis* is elongated and fusiform, while that of *B. serrulata* is nearly spherical. In both, the leaves are borne on branches from the top of the stem.

Macrozamia, with more than a dozen species, is the dominant genus, and it ranges from the northern part of Queensland to the southern limit cycads in New South Wales, and has at least one species in western Australia.

Most of the species have tuberous, subterranean stems. Among these species, *M. spiralis* is probably the most abundant and widely distributed. It is generally believed that spe-

cies in cycads are rather fixed, but a study of this species and associated species would soon convince one that there is great variation and, perhaps, mutation. Some of the species, like *M. Miquelii*, closely resemble *M. spiralis*; while others, like *M. heteromera*, bear less resemblance; but nevertheless, specimens of these two species could be selected which so closely resemble each other, that some call them both *M. spiralis*.

M. corallipes, *M. Fawcetti* and *M. Pauloguilelmi* rather closely resemble *M. spiralis*. A field study of several species warrants the suggestion that *M. spiralis* is the source from which the rest of the tuberous species have been derived.

There are only three species with tall, cylindrical trunks, and these are so distinct that they are easily recognized at a glance. All three species are found in Queensland—*M. Denisoni*, on Tambourine Mountain near Brisbane, is regarded by Eichler as the most beautiful species of the genus. The ovulate cones are nearly a meter long and reach a weight of 35 kilos. The seeds are so large that they are used as match boxes. *Macrozamia Moorei*, almost on the Tropic of Capricorn, at Springsure, is of more than ordinary interest on account of its close resemblance to the Mesozoic Bennettitales. Unfortunately, the leaves of this species, like those of most cycads, contain a poison which is very disastrous to cattle; consequently, cattlemen are trying to exterminate the plant, and are succeeding so well—or, from another standpoint, so badly—that in a few years it may be impossible to get a specimen for a conservatory. They poison the plant by chopping a notch and injecting arsenic into the pith.

Macrozamia Hopei, in the Cairns district, is the tallest of all cycads. I did not see it, except in cultivation, but Dr. F. M. Bailey told me that the statement in his "Flora of Queensland" that the species reaches a height of 60 feet (about 18 meters) is based upon reliable information.

Material, photographs and notes for an extended study of all the Australian genera and most of the species have already been secured,

and collections to make the life history studies more complete are being forwarded to Sydney, where they are cared for by Professor Maiden. This work will be continued by my friend, Professor A. A. Lawson.

The two African genera, *Stangeria* and *Encephalartos*, are confined to a narrow strip along the southeastern coast, and throughout most of the range the two genera are associated.

Stangeria is quite fern-like in appearance and was described as a species of *Lomaria* before the cones were discovered. There is probably only one species, *S. paradoxa*, although several attempts have been made to make more species. A species maker, unfamiliar with *Stangeria* in the field, could easily be tempted by carefully selected plants, or even by different leaves from the same plant, for leaves vary from entire to serrate, and sometimes the serrations are so deep that the leaf becomes almost bipinnate. We all know what gardeners can do with ferns of the *Nephrolepis* type.

Stangeria is most abundant on the open grass velt, where it grows in dense grass as tall as the plant itself. It also grows in the shade in the bush velt, and here it becomes much taller than in exposed situations. Were it not for the obvious relation between the grass velt and bush velt forms, one might describe them as distinct species.

Stangeria in the field, with one, two or three leaves, and only rarely with five or six, presents a striking contrast to the cultivated plant, with its abundant foliage.

My own collections, supplemented by collections made in Zululand by Professor W. C. Worsdell, and in the Transvaal by Professor W. T. Saxton, and particularly by collections made near Kentani by Miss Sarah van Rooyen, have made the series for morphological study very complete.

Encephalartos, with about a dozen species, is the dominant genus. I was able to study nine species in the field and saw the rest in botanical gardens. The various species may be placed in three fairly definite groups, one with the stems tuberous and subterranean or

extending slightly above the surface; and the other two with stout cylindrical trunks.

Encephalartos villosus, the most familiar species in cultivation, is a type of the tuberous group. It grows in the shade, has a wide range, and at various places is associated with species of the other two groups. *E. brachyphyllus* in Zululand is an interesting but little-known member of this tuberous group. Still less is known of *E. cycadifolius*, which I saw in the field only at East London. The ovulate cone is quite characteristic, but is clearly of the *E. villosus* type. *E. Hildebrandtii*, quite familiar in cultivation, does not occur as far south as Zululand, and, consequently, I did not see it in the field, but it certainly belongs to the *E. villosus* group.

E. caffer may be taken as the type of one of the two groups with cylindrical stems. It is abundant at Van Staadens, near Port Elizabeth, where it grows in the sun, on rocky mountain sides. The ovulate cones are the largest ever reported for any gymnosperm, sometimes reaching a weight of 90 pounds (45 kilos).

A nearly related species, *E. Altensteinii*, quite common in cultivation, was studied at various places from Zululand to East London. This species looks so much like *E. caffer* that the labels in botanical gardens are not always convincing, and local botanists assured me that they could always select leaves from *E. Altensteinii*, which taxonomists, at a distance, would identify as *E. caffer*. Some confusion may have crept into the literature through such practical jokes. A young plant of *E. Altensteinii*—and a plant 100 years old might be called young—could hardly be mistaken for *E. caffer*; but an old plant is sure to make trouble, if one is trying to identify it with a manual. A fine specimen of *Encephalartos* in the Botanical Garden at Melbourne, Australia, bore no label, and the director informed me that he had removed the label, placed there about fifty years before by Baron von Müller, who had identified the plant as *E. Altensteinii*, because the specimen did not agree with that description. A couple of young leaves, doubtless due to a wound at the base

of the trunk, showed typical *E. Altensteinii* characters. In Baron von Müller's time the plant probably agreed with the taxonomic description, which was certainly based upon a young plant. No plant of *E. Altensteinii* with a trunk more than three meters high is likely to agree with the taxonomic diagnosis.

The big cones, as in most of the species, have seeds with a brilliant red seed coat.

The remaining section, which might be called the *horridus* section, on account of its forbidding leaves, comprises four species, all confined to the southern part of the cycad range.

Encephalartos Frederici Guilelmi occurs in greatest abundance at Queenstown and Cathcart. It has a majestic trunk and a fine crown of glaucous leaves. The leaflets are pungently pointed but the margins are not spiny, so that it is only by the numerous intergrades between this species and the next that it deserves a place in the *horridus* section. No other cycad has such a densely tomentose bud. The cones, sometimes five or six in number, are lateral and are arranged around a central bud.

Encephalartos Lehmannii is often confused with the preceding species, but has a broader leaflet, which may be entire, or spiny or may have big, coarse teeth like *E. horridus*. The staminate cones, which have a reddish color and are not very hairy, distinguish the species at a glance. The ovulate cones are equally characteristic, being very tomentose in *E. Frederici Guilelmi* and nearly smooth in *E. Lehmannii*.

The type of the section is *E. horridus*, whose jagged leaves, as sharp and rigid as if they had been cut out from sheets of tin, give this plant a clear title to its name. No cycad is more xerophytic and the various aloes, cotyledons and crassulas associated with it would make a fine study for an ecologist.

An almost unknown member of this section, which I saw only at Trapps Valley, in the vicinity of Grahamstown, is *E. latifrons*. It occurs in the open grass veld and the plants are widely separated from one another, half a mile or more apart. The leaflet is jagged,

like that of *E. horridus*, but the trunks are stouter and the cones several times larger. The growth is even slower than in *Dioon edule*. Two plants, about one meter in height, on a lawn at Trapps Valley, have been under observation for nearly fifty years, and I was assured that they always bore leaves, sometimes new leaves, but that they were no taller than when first set out.

One object of the trip was to secure material for a complete morphological study of the five oriental genera. Through the generous cooperation of directors of botanical gardens and local botanists, this object was attained in far greater measure than I had dared to hope.

Even a morphologist should know his material in the field, and so I made careful observations and notes on all the species I could find. One result of the field study was not anticipated. From a field study of the Mexican genera, I had begun to regard the species of cycads as rather rigid. Of the four western genera, *Dioon*, *Ceratozamia* and *Microcycas* are monotypic or nearly so; *Zamia*, with its thirty or more species, would probably show considerable variation if one could study it from Florida to Chili. The *spiralis* section of *Macrozamia* in Australia and the three sections of *Encephalartos* in Africa show that some cycads are still plastic and show variations which may be fluctuating or which may be mutations. Unfortunately, most cycads do not produce cones until they are from twenty to fifty years of age, and, consequently, one could not begin experimental work with much prospect of seeing results.

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TWENTY-FIRST ANNUAL MEETING OF
THE SOCIETY FOR THE PROMOTION
OF ENGINEERING EDUCATION

THE regular annual meeting of the Society for the Promotion of Engineering Education was held in Minneapolis from June 24 to 26 inclusive. The principal sessions were held in the new Engineering Building of the University of Minnesota and in the West Hotel, the latter being a joint session with the American Water Works Association. A comprehensive series of papers was presented by